

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference T-9108	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/JP 00/07209	International filing date (day/month/year) 18/10/2000	(Earliest) Priority Date (day/month/year) 18/10/1999
Applicant TOKIN CORPORATION et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

COMPOSITE MAGNETIC BODY AND ELECTROMAGNETIC INTERFERENCE SUPPRESSING BODY USING THE SAME

5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP 00/07209

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The abstract is modified as follows:

Line 2, "harogen-containing" must be "halogen-containing".

Line 2 and 3, "harogen-based" must be "halogen-based".

INTERNATIONAL SEARCH REPORT

International Application No

JP 00/07209

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7⁻ H01F1/26 H05K9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01F H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 21 37 487 A (LICENTIA GMBH) 1 February 1973 (1973-02-01) page 3, paragraph 2; claims 1,3 ---	1-3,6
X	US 4 731 191 A (SWIHART TERENCE J) 15 March 1988 (1988-03-15) column 4, line 65 -column 5, line 2; claims 1,2; example 4 ---	1-3
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 09, 31 July 1998 (1998-07-31) & JP 10 092623 A (TOKIN CORP), 10 April 1998 (1998-04-10) abstract --- -/--	1,8,9, 11,18,19

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

3 January 2001

Date of mailing of the international search report

11/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

Decanniere, L

INTERNATIONAL SEARCH REPORT

International Application No

JP 00/07209

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5 498 644 A (REO NED J) 12 March 1996 (1996-03-12)</p> <p>claims 1,2,4,5 -----</p>	<p>1-3,8,9, 11-13, 18,19</p>

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

/JP 00/07209

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 2137487	A	01-02-1973	NONE	
US 4731191	A	15-03-1988	NONE	
JP 10092623	A	10-04-1998	NONE	
US 5498644	A	12-03-1996	NONE	



PATENT COOPERATION TREATY

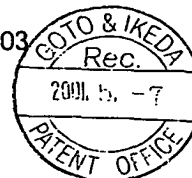
PCT

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

GOTO, Yosuke
The 3rd Mori Building
4-10, Nishishinbashi 1-chome
Minato-ku
Tokyo 105-0003
JAPON

Date of mailing (day/month/year) 26 April 2001 (26.04.01)		IMPORTANT NOTICE	
Applicant's or agent's file reference T-9108			
International application No. PCT/JP00/07209	International filing date (day/month/year) 18 October 2000 (18.10.00)	Priority date (day/month/year) 18 October 1999 (18.10.99)	
Applicant TOKIN CORPORATION et al			

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
CN,EP,SG

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
26 April 2001 (26.04.01) under No. WO 01/29851

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))



To:

GOTO, Yosuke
The 3rd Mori Building
4-10, Nishishinbashi 1-chome
Minato-ku
Tokyo 105-0003
JAPON

Date of mailing (day/month/year) 15 November 2000 (15.11.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference T-9108	International application No. PCT/JP00/07209

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

TOKIN CORPORATION (for all designated States except US)

AWAKURA, Yoshio et al (for US)

International filing date : 18 October 2000 (18.10.00)
Priority date(s) claimed : 18 October 1999 (18.10.99)
Date of receipt of the record copy
by the International Bureau : 06 November 2000 (06.11.00)
List of designated Offices :

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
National : CN, KR, SG, US


ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase
- ☒ confirmation of precautionary designations
- ☒ requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer:  Masashi HONDA
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38



INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. It is the applicant's responsibility to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
26 April 2001 (26.04.2001)

PCT

(10) International Publication Number
WO 01/29851 A1

(51) International Patent Classification⁷: **H01F 1/26,**
H05K 9/00

(21) International Application Number: **PCT/JP00/07209**

(22) International Filing Date: 18 October 2000 (18.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/295440 18 October 1999 (18.10.1999) JP

(71) Applicant (for all designated States except US): **TOKIN CORPORATION [JP/JP]**; 7-1, Koriyama 6-chome, Taihaku-ku, Sendai-shi, Miyagi 982-8510 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **AWAKURA, Yoshio [JP/JP]**; Tokin Corporation, 7-1, Koriyama 6-chome, Taihaku-ku, Sendai-shi, Miyagi 982-8510 (JP). **YOSHIDA,**

Shigeyoshi [JP/JP]; Tokin Corporation, 7-1, Koriyama 6-chome, Taihaku-ku, Sendai-shi, Miyagi 982-8510 (JP). **NISHIMURA, Mikio [JP/JP]**; Tohoku Chemical Industries, Ltd., 9-4, Nishi-gotanda 7-chome, Shinagawa-ku, Tokyo 141-0031 (JP).

(74) Agents: **GOTO, Yosuke et al.**; The 3rd Mori Building, 4-10, Nishishinbashi 1-chome, Minato-ku, Tokyo 105-0003 (JP).

(81) Designated States (national): CN, KR, SG, US.

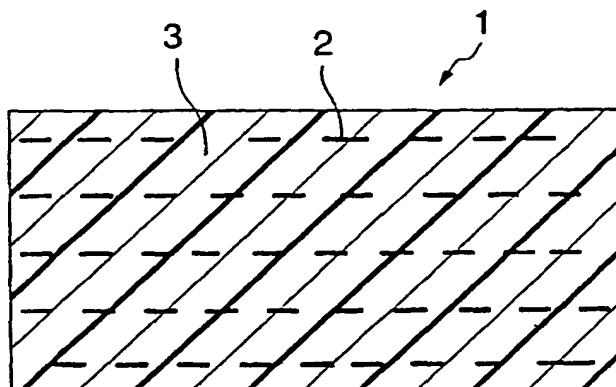
(84) Designated States (regional): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:

— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: COMPOSITE MAGNETIC BODY AND ELECTROMAGNETIC INTERFERENCE SUPPRESSING BODY USING THE SAME



(57) Abstract: A composite magnetic body is obtained without the use of halogen-based or halogen-containing materials, such as, halogen-based binding agent of halogen-based resins or elastomers, and bromine-based fire retardants. The composite magnetic body (1) comprises a soft magnetic powder (2) and a silicone rubber (3). The silicone rubber (3) should preferably be a solid silicone rubber or a chemically setting liquid silicone rubber. An electromagnetic interference suppressing body is obtained using this composite magnetic body.

WO 01/29851 A1



INTERNATIONAL SEARCH REPORT

National Application No

PCT/JP 00/07209

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01F1/26 H05K9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01F H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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EPO-Internal, PAJ, WPI Data

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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 09, 31 July 1998 (1998-07-31) & JP 10 092623 A (TOKIN CORP), 10 April 1998 (1998-04-10) abstract --- -/--	1,8,9, 11,18,19



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
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- *Y* document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

3 January 2001

Date of mailing of the international search report

11/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Decanniere, L



INTERNATIONAL SEARCH REPORT

onal Application No
PCT/JP 00/07209

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5 498 644 A (REO NED J) 12 March 1996 (1996-03-12)</p> <p>claims 1,2,4,5</p>	<p>1-3,8,9, 11-13, 18,19</p>

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/JP 00/07209

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 2137487	A	01-02-1973	NONE	
US 4731191	A	15-03-1988	NONE	
JP 10092623	A	10-04-1998	NONE	
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(72) Inventors; and

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Shigeyoshi [JP/JP]; Tokin Corporation, 7-1, Koriyama
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NISHIMURA, Mikio [JP/JP]; Tohoku Chemical Indus-
tries, Ltd., 9-4, Nishi-gotanda 7-chome, Shinagawa-ku,
Tokyo 141-0031 (JP).

(74) Agents: GOTO, Yosuke et al.; The 3rd Mori Build-
ing, 4-10, Nishishinbashi 1-chome, Minato-ku, Tokyo
105-0003 (JP).

(81) Designated States (national): CN, KR, SG, US.

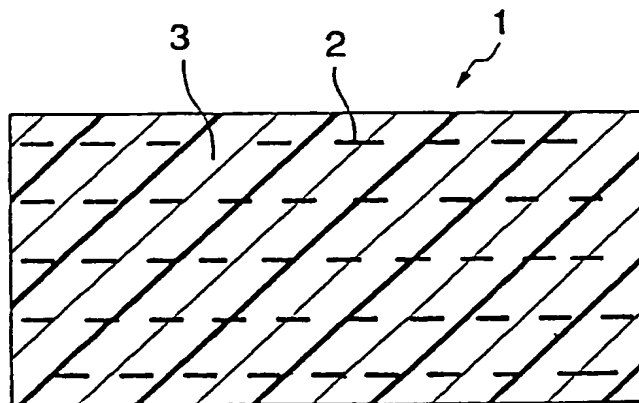
(84) Designated States (regional): European patent (AT, BE,
CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
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ning of each regular issue of the PCT Gazette.

(54) Title: COMPOSITE MAGNETIC BODY AND ELECTROMAGNETIC INTERFERENCE SUPPRESSING BODY USING
THE SAME



(57) Abstract: A composite magnetic body is
obtained without the use of halogen-based or
halogen-containing materials, such as, halogen-based
binding agent of halogen-based resins or elastomers,
and bromine-based fire retardants. The composite
magnetic body (1) comprises a soft magnetic powder
(2) and a silicone rubber (3). The silicone rubber
(3) should preferably be a solid silicone rubber
or a chemically setting liquid silicone rubber. An
electromagnetic interference suppressing body is
obtained using this composite magnetic body.

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COMPOSITE MAGNETIC BODY AND ELECTROMAGNETIC INTERFERENCE SUPPRESSING BODY USING THE SAME

TECHNICAL FIELD

The present invention relates to a composite magnetic body used to suppress electromagnetic interference brought about by interference from unwanted electromagnetic waves in a high-frequency band and to an electromagnetic interference suppressing body obtained by the use thereof, and more particularly to a such a composition of a fireproof type.

BACKGROUND ART

Cellular phones, personal computers, and other types of electronic equipment operated at high frequencies such as quasi-microwave band have become more widespread in recent years. In particular, smaller and lighter devices are urgently needed, with electromagnetic noise/interference posing a serious problem.

In view of this, composite magnetic bodies and electromagnetic interference suppressing bodies are being commercialized as a means of countering such high-frequency electromagnetic interference.

Conventional composite magnetic bodies and electromagnetic interference suppressing bodies obtained by the use thereof are fireproofed by use of halogen-based fire retardants or by means of antimony trioxide as a fire retardant aid. Typically, such fireproofing techniques using halogen-based fire retardants and/or antimony trioxide fire-retardant aid are ordinary methods that are also applied to coating materials for electric wires or the like; casings for

electronic equipment; and other products.

In some composite magnetic bodies, chlorinated polyethylene is used as a binding agent in order to improve the fire resistance characteristics or the filling properties of soft magnetic powders, and they also contain chlorine, which is a halogen.

There is a problem indications indicated that dioxins might be released under certain incineration conditions during the incineration disposal of chlorine-contained materials, although it has not yet completely understood.

Another problem, currently difficult to prove because of the absence of reliable reports, is a possible release of dioxins by fire retardants and other halogen-containing materials.

Concern is mounting regarding environmental issues and health safety, creating a need for the development of materials that are free of halogens and do not harm the environment.

In view of this, it is an object of the present invention to provide a composite magnetic body that is completely free of halogen-containing materials, for example, halogen-containing binding agents such as halogen-based resins or elastomers, and halogen-containing bromine-based fire retardants.

It is another object of the present invention to provide an electromagnetic interference suppressing body using this composite magnetic body.

DISCLOSURE OF THE INVENTION

In order to attain the stated objects, the present invention is directed to fireproof of a composite magnetic material without use of a halogen-based binding agent with good powder filling properties in the material and a halogen-based fire retardant having an adequate fire resistance effect.

According to an aspect of the present invention, there is obtained a composite magnetic body comprising a silicone rubber and a soft magnetic powder dispersed in the silicone rubber.

Preferably, in the aspect of the present invention, the silicone rubber may be a solid silicone rubber or a liquid silicone rubber of a chemically-setting type.

The silicone rubber may contain an additive containing at least one selected from a group consisting of platinum, silicon, titanium, iron, copper, nickel, and cobalt.

The silicone rubber may contain carbon black.

The soft magnetic powder may be a magnetic alloy powder having a flat shape.

The soft magnetic powder may have a specific surface area of 0.1–3 m²/g, have an aspect ratio of 3 or more.

The soft magnetic powder may be surface-treated with a coupling agent having a SP value ranges from 6 to 10.

The coupling agent may be at least one compound selected from titanate, aluminate, and silane.

Also, the soft magnetic powder may be surface-treated with a primer having a SP value less than that of the soft magnetic powder but greater than that of the silicone rubber.

According to another aspect of the present invention, there is obtained an electromagnetic interference suppressing body characterized in that the aforementioned composite magnetic body is used to suppress electromagnetic interference brought about by interference from unwanted electromagnetic waves.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view depicting the overall structure of a composite magnetic body according to an embodiment according of the present invention; and

Fig. 2 is a diagram depicting the results of Vertical Burning Test UL 94V as a function of the specific surface area of the soft magnetic powder used in the composite magnetic body according to the embodiment of the present invention.

BEST MODE FOR EMBODYING THE INVENTION

Embodiments of the present invention will now be described with reference to drawings.

Referring to Fig. 1, the composite magnetic body 1 comprises a binding agent composed of silicone rubber, and a flat soft magnetic powder 2 whose planar surfaces lie along the same plane, horizontal plane in Fig. 1.

This composite magnetic body functions as an electromagnetic interference suppressing body for suppressing electromagnetic interference brought about by interference from unwanted electromagnetic waves when this composite magnetic body is used for the internal or peripheral portions of electrical devices. Consequently, the composite magnetic body of the present embodiment will be treated as the below-described composition obtained by the method described below, and will be referred to as an electromagnetic interference suppressing body when the composite magnetic body thus obtained is used for the internal or peripheral portions of electrical devices. Specifically, the composite magnetic body and electromagnetic interference suppressing body will be referred to differently because they are identical in terms of constituent components and manufacturing steps but different in terms of application. In the description that follows, this fact is emphasized by

employing different terms for the above-described reasons whenever a composite magnetic body or an electromagnetic interference suppressing body is mentioned.

As referred to herein, silicone rubber is one described in, for example, the section "silicone" in the Dictionary of Natural Sciences published by Iwanami Shoten. That is, "Polymers whose main chain consists of repeating silicone bonds $-(\text{Si-O})_n-$ and whose side groups consist of alkyl, aryl, or other groups are collectively referred to as silicones. Not to be confused with silicon. Because of their molecular structure, silicones have excellent heat resistance, water repellency, electrical insulation, chemical resistance, aging resistance, and other properties. Depending on their degree of polymerization, type of side group, extent of cross-linking, and the like, silicones can be in the form of grease, rubber, or resin. A linear silicone with a low degree of polymerization that is fluid at normal temperature is called silicone oil; commonly it is a dimethyl dichlorosilane polymer. A compound obtained by the moderate cross-linking of a highly polymerized linear polydimethylsiloxane or a copolymer thereof and provided with rubber-like elasticity is called silicone rubber. A compound obtained by the hydrolysis and polycondensation of a chlorosilane derivative $\text{R}_n\text{SiCl}_{(4-n)}$ and provided with a highly developed three-dimensional reticulated structure is called silicone resin or silicon resin."

An embodiment of the composite magnetic body and electromagnetic interference suppressing body according to the present invention will now be described.

Example 1

The mixed formulation of the composite magnetic body according to Example 1 of the present invention is shown in Table 1 below. An Fe-Si-Al alloy powder (soft magnetic powder) was used as a filler. The same results were obtained when a composition based on Fe-Si-Al-Ni or the like was used as

the soft magnetic powder. The composition used in Example 1 comprised 6–11 wt% Si and 4–7 wt% Al, with Fe constituting the balance. The powder had a mean grain size of 32 μm .

A kneaded magnetic material was first obtained by employing mixing rolls to knead 273 weight parts of the aforementioned soft magnetic powder, 100 weight parts of solid silicone rubber (binding agent), and 2 weight parts of a cross-linking agent. The same kneaded magnetic material could be obtained using a kneader, intensive mixer, or other kneading apparatus to perform the aforementioned kneading operation.

The resulting kneaded composite magnetic material was rolled between rolls arranged in parallel, yielding a composite magnetic body in the form of a sheet. An extruder could be used in addition to such rolls in order to obtain the sheeted composite. Press molding or another molding method capable of producing the desired shape could also be used.

The sheet was subsequently heat-pressed and subjected to a cross-linking reaction, yielding a sheeted composite magnetic body. The composite magnetic body manufactured by the above-described method functions as an electromagnetic interference suppressing body for suppressing electromagnetic interference brought about by interference from unwanted electromagnetic waves when this composite magnetic body is used for the internal or peripheral portions of electrical devices. A conventional example is also shown in Table 1 below in order to draw a comparison with Example 1 of the present invention. To facilitate comparison, the manufacturing method was performed under the same conditions as in Example 1.

The conventional example is markedly different from the present example in that a halogen-containing chlorinated polyethylene was used for the binding agent, and a halogen-containing brominated polymer was used for the fire retardant. In addition, antimony trioxide was used as a fire retardant aid.

Table 1

Mixing Composition	Example 1 (weight parts)	Example 2 (weight parts)	Example 3 (weight parts)	Conven- tional Example (weight parts)
(Binding Agent)				
silicone rubber (solid)	100			
silicone rubber (2-component liquid)		100		
silicone rubber (1-component liquid)			100	
chlorinated polyethylene				100
(Filler: Soft Magnetic Powder)				
Fe-Al-Si alloy Mean Grain Size: 32 μ m	273	273	273	273
(Fire Retardant)				
bromine-based polymer	0	0	0	20
(Fire Retardant Aid)				
antimony trioxide	0	0	0	20
(Cross-Linking Agent)				
peroxide	2	0	0	2

Example 2

A mixed formulation for the composite magnetic body according to Example 2 of the present invention is shown in Table 1 above together with Example 1.

The same Fe-Si-Al alloy powder as in Example 1 was used as a filler. As in Example 1, the same results were obtained when a composition based on Fe-Si-Al-Ni or the like was used as the soft magnetic powder.

A mixer was used to first mix an Fe-Si-Al alloy powder (soft magnetic powder) in an amount of 273 weight parts with a curing agent and a two-component liquid silicon rubber (main ingredient), used in a combined amount of 100 weight parts. The total amount of the three components was 373 weight parts. The composite magnetic material thus uniformly dispersed and mixed was molded into a composite magnetic body having a desired shape by using an injection molding machine. The material in the injection mold was

made into a sheet and cured, yielding a composite magnetic sheet. Extrusion molding, press molding, or roll molding could also be used to manufacture the composite magnetic body in accordance with the present example 2.

Example 3

A mixed formulation for the composite magnetic body according to Example 3 of the present invention is shown in Table 1 above together with Examples 1 and 2.

The same Fe-Si-Al alloy powder (soft magnetic powder) as in Example 1 was used as a filler. The same results were obtained when a composition based on Fe-Si-Al-Ni or the like was used as the soft magnetic powder.

In Example 3, 273 weight parts of the aforementioned soft magnetic powder and 100 weight parts of a single-component liquid silicone rubber were first mixed with the aid of a mixer. The total amount of the two components was 373 weight parts. The uniformly dispersed and mixed composite magnetic material was molded into a composite magnetic body by using an injection molding machine in the same manner as in Example 2. The material in the injection mold was made into a sheet and cured, yielding a composite magnetic sheet. Extrusion molding, press molding, or roll molding could also be used to manufacture the composite magnetic body in accordance with the Example 3.

Results of burning tests involving composite magnetic sheets obtained in Examples 1-3 and a conventional example will now be described with reference to Table 2 below. Because composite magnetic bodies are often used for electronic components, the burning tests were performed as the below-described Vertical Burning Test UL 94V in accordance with the UL safety standards for the combustibility testing of plastic materials for equipment parts. The samples had a length of 127 mm, a width of 12.7 mm, and a thickness of 0.3 mm. The vertical burning tests were conducted using sample Nos. 1-5 (a

total of five test pieces). The column titled "First Lingering Flame" shows the combustion time (in seconds) elapsed following a first flame contact, the column titled "Second Lingering Flame" shows the combustion time elapsed following a second flame contact, and the column titled "Second Lingering Flame + Smoldering Material" shows the combined smoldering time and combustion time elapsed following the second flame contact. "Smoldering time" refers to the time elapsed after flame burning has stopped, or the time during which a material burns without flame in the absence of flame burning.

Table 2

Example 1	No.	Thickness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
silicone rubber (solid)	1	0.30	19	31	57	Horizontal Burning Test HB
	2	0.30	25	26	36	
	3	0.30	23	33	50	
	4	0.30	20	34	48	
	5	0.30	32	20	36	

Example 2	No.	Thickness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
silicone rubber (2-component liquid)	1	0.30	25	27	54	Horizontal Burning Test HB
	2	0.30	28	30	55	
	3	0.30	26	28	53	
	4	0.30	33	28	55	
	5	0.29	26	35	58	

Example 3	No.	Thickness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
silicone rubber (1-com- ponent liquid)	1	0.30	28	23	56	Horizontal Burning Test HB
	2	0.30	30	29	58	
	3	0.30	28	33	56	
	4	0.29	27	29	55	
	5	0.30	31	22	35	

Conven- tional Example	No.	Thickness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
chlori- nated poly- ethylene halogen- based fire retardant	1	0.30	2	1	5	V-0 satisfied
	2	0.30	4	2	6	
	3	0.30	3	2	6	
	4	0.30	4	1	4	
	5	0.30	3	1	5	

The conventional example satisfies Class V-0 requirements when subjected to vertical testing in accordance with Fire Resistance Standard UL 94V. However, chlorinated polyethylene was used as the binder and a halogen-based bromine was used as the fire retardant. The halogen content in the composite magnetic body was about 10%, assuming the overall weight of the composite magnetic body was 100.

By contrast, the above-described Example 1 is halogen-free, making it possible to achieve so-called un-halogenation. However, the example fails to meet Classes V-0 and V-1 of the same standard in Vertical Burning Test UL 94V. It is still possible to satisfy the requirements of Horizontal Burning Test UL 94HB, which is less stringent than Vertical Burning Test UL 94V.

Although composite magnetic bodies using the chemically setting liquid silicone rubber in Examples 2 and 3 fail to satisfy the requirements corresponding to Classes V-0 and V-1 of Vertical Burning Test UL 94V, they satisfy the requirements of Horizontal Burning Test UL 94HB, which is less stringent than the aforementioned standard in terms of fire resistance. It is thus possible to fill silicone rubber, which is a halogen-free binding agent, with a soft magnetic powder and to fabricate a composite magnetic body. It has also been confirmed that the resulting fire resistance corresponds to Class UL 94HB.

An attempt was made to improve fire resistance even further by employing a method in which silicone rubber (binding agent) was rendered fire resistant. Table 3 shows combustion times obtained when various fire retardants were added per 100 weight parts of silicone rubber in a fire-resistant mixture. According to the results obtained, combustion time is reduced from 24–45 seconds in comparison with the use of silicone rubber alone. This is because adding a fire retardant has the effect of slowing down the decomposition of siloxane bonds (main chains of silicone rubber) during combustion, thereby suppressing the combustion process.

Table 3

	Additive	Amount	Combustion Time (seconds)
Mixture 1	platinum silicon dioxide	55ppm 60	43
2	platinum silicon dioxide carbon black	55ppm 60 2	22
3	platinum silicon dioxide ferrous oxide	55ppm 60 5	32
4	platinum silicon dioxide ferric oxide	55ppm 60 5	33
5	platinum silicon dioxide titanium oxide	55ppm 60 5	30
6	platinum silicon dioxide copper dioxide	55ppm 60 5	41
7	platinum silicon dioxide nickel	55ppm 60 5	40
8	platinum silicon dioxide nickel	55ppm 60 5	40
	silicone rubber alone	0	67

Further studies are to be performed concerning the fireproofing of composite magnetic bodies by making use of platinum, silicon dioxide, and carbon black as such additives.

Example 4

The mixing composition of a composite magnetic body according to a fourth embodiment of the present invention is shown in Table 4 below as Example 4. With the exception of the fire retardant, the same mixture was used for the above-described silicone rubber in order to be able to draw a comparison with Example 1.

Table 4

Mixing Composition	Example 4 (weight parts)
(Binding Agent) silicone rubber (solid)	100
(Fire Retardant) platinum silicon dioxide carbon black	55ppm 60 2
(Filler: Soft Magnetic Powder) Fe-Al-Si alloy Mean Grain Size: 32 μ m	273
(Cross-Linking Agent) peroxide	2

Mixing rolls were first used to knead and disperse 100 weight parts of solid silicone rubber (binding agent), 2 weight parts of a cross-linking agent, 55 weight parts (ppm) platinum (fire retardant), 60 weight parts silicon dioxide, and 2 weight parts carbon black. The resultant mixture was further mixed and kneaded with 273 weight parts of an Fe-Si-Al alloy powder (soft magnetic powder) by the aid of mixing rolls. The similar kneaded magnetic material could also be obtained by using a kneader, intensive mixer, or other kneading apparatus to perform the kneading operation.

The resulting kneaded composite magnetic material was rolled between rolls arranged in parallel, thereby yielding a composite magnetic body in the form of a sheet. An extruder could be used in addition to such rolls in order to obtain the sheeted composite. Press molding or extrusion molding shape could also be used.

The sheet was subsequently heat-pressed and subjected to a cross-linking reaction, thereby yielding a sheeted composite magnetic body.

The composite magnetic body manufactured by the above-described method functions as an electromagnetic interference suppressing body for suppressing electromagnetic interference brought about by interference from

unwanted electromagnetic waves when this composite magnetic body is used for the internal or peripheral portions of electrical devices.

Results of burning tests involving the composite magnetic sheet of Example 4 are shown in Table 5 below. Fire resistance is improved in comparison with Examples 1–3, and the results correspond to Class V-1 of Vertical Burning Test UL 94V.

Table 5

Example 4	No.	Thickness (mm)	First Linger Flame	Second Linger Flame	Second Linger Flame + Smoldering Material	Class
silicone rubber (solid) with Fire Retardant added	1	0.30	18	13	23	V-1
	2	0.30	21	11	22	
	3	0.30	16	15	25	
	4	0.30	19	18	33	
	5	0.29	12	16	22	

Comparisons were made concerning the combined lingering flame time (seconds) following a first flame contact and lingering flame time following a second flame contact (that is, the lingering flame time (in seconds) following all ten flame contacts) for each of the five test piece Nos. 1–5, and it was found that whereas this time was 263 seconds in Example 1, it was only 159 seconds, or 106 seconds less, in Example 4.

Example 5

Similar to Example 4, the same mixtures and methods were used for all ingredients except the soft magnetic powder. The Fe-Si-Al alloy powder used in Example 4 was treated for another 5 hours with an attritor, yielding flat-shaped particles, and the resulting Fe-Si-Al alloy powder with a mean grain size of 37 μm was used as the soft magnetic powder (filler).

Mixing rolls were first used to knead and disperse 100 weight parts of solid silicone rubber (binding agent), 2 weight parts of a cross-linking agent (vulcanizing agent or curing agent), 55 weight parts (ppm) platinum, 60 weight parts silicon dioxide, and 2 weight parts carbon black (fire retardants). The resultant mixture was further mixed and kneaded with 273 weight parts of the aforementioned flat Fe-Si-Al alloy powder by the aid of mixing rolls. The resulting kneaded composite magnetic body was rolled between rolls arranged in parallel, thereby yielding a composite magnetic body in the form of a sheet.

The sheet was subsequently heat-pressed and subjected to a cross-linking reaction, thereby yielding a sheeted composite magnetic body.

The composite magnetic body was tested for fire resistance and was found to correspond to Class V-1 of Vertical Burning Test UL 94V, as shown in Table 7 below.

Then, attempting to grade up fireproof above Class V-1, various experiments were performed, but it was impossible to achieve Fire Resistance Standard V-0 with combination of silicone rubber and a soft magnetic powder, especially, a soft magnetic alloy powder. This is because the flammability of the composite magnetic material is promoted due to high thermal conductivity and/or the catalytic action of the soft magnetic alloy powder, thus making it extremely difficult to achieve self-extinguishing, which is the main element of fire resistance. In addition, the soft magnetic metal powder itself is often an active flammable solid, thereby making it more difficult to achieve self-extinguishing.

In view of this, an attempt was made to manage fire resistance by varying the grain size of the soft magnetic powder in order to achieve the desired level of fire resistance. However, grain size merely determines the particulate size of the powder and does not reflect the surface state of the powder, that is, the area of the surface in contact with air and other media. In addition, fire resistance varies with the grain size distribution of a powder.

Table 6

Mixing Composition	Example 6 (weight parts)	Example 7 (weight parts)
(Binding Agent) silicone rubber (solid) platinum silicon dioxide carbon black	100 55ppm 60 2	100 55ppm 60 2
(Filler: Soft Magnetic Powder) Treatment by Attritor for 17 hours flat shape Fe-Al-Si alloy Mean Grain Size: 32 μ m Specific Surface Area: 1.6m ² /g	273	
Treatment by Attritor for 17 hours flat shape Fe-Al-Si alloy Mean Grain Size: 32 μ m Specific Surface Area: 1.5m ² /g Aspect Ratio: 28		273
Cross-Linking Agent	2	2

Table 7

Example 5	No.	Thick- ness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
Treatment by flat-shaped soft magnetic attritor for 5 hours	1	0.30	19	11	23	V-1
	2	0.31	22	13	20	
	3	0.30	20	16	24	
	4	0.29	18	18	28	
	5	0.30	23	20	30	

Example 6	No.	Thick- ness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
Soft Magnetic Powder having Specific Surface Area of 1.5m ² /g	1	0.29	4	1	5	V-0 Satisfied
	2	0.30	3	2	6	
	3	0.30	2	1	5	
	4	0.30	4	1	4	
	5	0.30	4	1	4	

Example 7	No.	Thick- ness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
Soft Magnetic Powder having Aspect Ratio of 28	1	0.29	6	1	5	V-0 Satisfied
	2	0.30	5	2	6	
	3	0.30	3	1	4	
	4	0.30	4	3	7	
	5	0.30	7	2	4	

Example 6

For the samples of Example 6, as shown in Table 6, the specific surface area of powder was used as a physical value that could be used to accurately define powder properties, and composite magnetic bodies were fabricated by limiting the surface area of soft magnetic powders to 0.1–3 m²/g.

Also shown here are the results of Vertical Burning Test UL 94V involving composite magnetic bodies obtained using soft magnetic powders with varying specific surface areas, as shown in Table 7. The composite magnetic

body was manufactured by the similar method as in Example 1. Fig. 2 also shows results of Vertical Burning Test UL 94V according to the specific surface areas of soft magnetic powders. When the specific surface area is $0.1 \text{ m}^2/\text{g}$ or less, the lingering flame time following all ten flame contacts is about 10 seconds. The time is 17 seconds, 20 seconds, or 37 seconds when the specific surface area is $0.6 \text{ m}^2/\text{g}$, $1.4 \text{ m}^2/\text{g}$, or $2.6 \text{ m}^2/\text{g}$, respectively. The time is 48 seconds when the specific surface area exceeds $3 \text{ m}^2/\text{g}$ (when it is $3.2 \text{ m}^2/\text{g}$), and reaches 415 seconds when the specific surface area is $4.1 \text{ m}^2/\text{g}$.

The results concerning the specific surface area of the soft magnetic powders and the fire resistance characteristics of the composite magnetic bodies indicate that the specific surface area thereof should be $3 \text{ m}^2/\text{g}$ or less in order to satisfy Class V-0 requirements of burning tests, taking into account the level of productivity acceptable in commercial terms. A product with a specific surface area of $0.1 \text{ m}^2/\text{g}$ or less corresponds to Class V-0 and exhibits self-extinguishing properties when subjected to a burning test. A narrower specific surface area has an adverse effect on magnetic characteristics and makes it impossible to obtain adequate electromagnetic interference suppression effects.

The same applies to a case in which the material used has the same Fe-Si-Al alloy composition as in Example 1 (Embodiment 1) and possesses a specific surface area of less than $0.1 \text{ m}^2/\text{g}$. This material has the necessary self-extinguishing properties, but its magnetic characteristics deteriorate due to the reduced powder flatness, and the product cannot suppress electromagnetic interference as a composite magnetic body.

In this example, the filler was a soft magnetic powder with a specific surface area of $1.6 \text{ m}^2/\text{g}$. The soft magnetic powder was an Fe-Si-Al alloy powder with the same composition as in Example 1 and a mean grain size of $32 \text{ }\mu\text{m}$. To make it easier to compare methods for manufacturing composite

magnetic bodies, the same manufacturing method as in Example 4 was used to obtain the composite magnetic body in this example.

Example 7

In Example 7, as shown in Table 6, the soft magnetic powder had the necessary flatness of a filler and possessed an aspect ratio of 28. The soft magnetic powder was an Fe-Si-Al alloy powder with the same composition as in Example 1 and a mean grain size of 32 μm . To make it easier to compare methods for manufacturing composite magnetic bodies, the same manufacturing method as in Example 4 was used to obtain the composite magnetic body in this example.

As can be seen in Table 7 above, Vertical Burning Test UL 94V involving Examples 7 and 8 satisfies V-0 requirements.

A study involving tight filling of soft magnetic powder into silicone rubber was also conducted. Although certain fire resistance was achieved, the filling ratio of the powders was low, resulting in unacceptable deterioration for magnetic characteristics. In view of this, magnetic characteristics were improved when the kneading time of mixing rolls was extended or the rotational speed ratio of the two rolls was set to 1.7 or higher in order to enhance shear and to increase the filling ratio of silicone powders, but these measures had a profoundly adverse effect on the moldability of composite magnetic materials and resulted in a significantly lower mechanical strength.

In view of this, a composite magnetic body was molded after surface treatment with a coupling agent (soft magnetic powder). As a result, magnetic permeability was raised from 12 to 17. This was because affinity between the soft magnetic powder and the binding agent was improved by the use of a coupling agent. In particular, the binding agent is decreased in the range of SP (Solubility Parameter) values and thereby is improved in solubility with silicone

rubber, so that a highly moldable composite magnetic body was obtained., For coupling agents, titanates, aluminates, silanes, and phosphates are primarily used, and the first three types of coupling agents improve the filling properties of soft magnetic powders because hydrophilic groups containing titanium, aluminum, and the like interact with soft magnetic powders and chemically bond with the surfaces of the soft magnetic powders.

Example 8

Table 8 shows the mixed formulation of the composite magnetic body according to Example 8 of the present invention is shown. To manufacture the composite magnetic body, 273 weight parts of the aforementioned soft magnetic powder was firstly subjected to a preliminary surface treatment wherein the powder was agitated together with 3 weight parts of a titanate-based coupling agent with an SP value of 8.6 were first by using a mixer or the like. During the surface treatment of a soft magnetic powder with a coupling agent, the surface treatment agent could be diluted with a diluent or the like to achieve uniform surface treatment. To make it easier to compare methods for the subsequent manufacture of magnetic bodies, the same manufacturing method as in Example 4 was used to obtain the composite magnetic body in this example.

As can be seen in Table 8 below, Vertical Burning Test UL 94V satisfies the Class V-0 requirements.

Table 8

Mixing Composition	Example 8 (weight parts)	Example 9 (weight parts)
(Binding Agent) silicone rubber (solid) platinum silicon dioxide carbon black	100 55ppm 60 2	100 55ppm 60 2
(Filler: Soft Magnetic Powder) Treatment by Attritor for 17 hours flat shape Fe-Al-Si alloy Mean Grain Size: 32 μ m Specific Surface Area: 1.5m ² /g Aspect Ratio: 28	273	273
(Coupling Agent) SP value: 8.6	3	
(Primer) SP value: Soft Magnetic Powder > Primer > silicone rubber	0	3
Cross-Linking Agent	2	2

Table 9

Example 8	No.	Thick- ness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
SP value: 8.6 Coupling Agent	1	0.29	2	1	5	V-0 Satisfied
	2	0.30	4	2	4	
	3	0.30	4	1	5	
	4	0.30	3	1	6	
	5	0.30	3	1	4	

Example 9	No.	Thick- ness (mm)	First Lingering Flame	Second Lingering Flame	Second Lingering Flame + Smoldering Material	Class
Treatment by Primer	1	0.29	2	1	5	V-0 Satisfied
	2	0.30	5	2	7	
	3	0.30	3	1	6	
	4	0.30	6	1	4	
	5	0.30	2	1	6	

Example 9

The mixed formulation of the composite magnetic body according to Example 9 of the present invention is shown in Table 8 above. First, 273 weight parts of the aforementioned soft magnetic powder was subjected to a preliminary surface treatment wherein the powder was agitated together with 3 weight parts of a primer which is recommended by a silicone rubber manufacturer and provided with an SP value intermediate between those of the soft magnetic powder and a binding agent, using a mixer or the like. During the surface treatment of the soft magnetic powder with the primer, the surface treatment agent may be diluted with a diluent or the like to achieve uniform surface treatment.

To make it easier to compare methods for the subsequent manufacture of composite magnetic bodies, the same manufacturing methods as in Example 4 were used to perform the processes downstream of the surface treatment step.

As can be seen in Table 8 above, the fire resistance of the composite magnetic bodies obtained in the present inventive example meet the Class V-0 requirements of Vertical Burning Test UL 94V.

As described above, the present invention allows a halogen-free, environmentally safe composite magnetic body and electromagnetic interference suppressing body to be obtained through the use of silicone rubber as a binding agent for the composite magnetic body. In addition, the composite magnetic sheet of the present invention, which was obtained by defining the physical properties of a soft magnetic powder in terms of specific surface area, had self-extinguishing properties (the main element of fire resistance) and satisfied Class V-0 requirements of Burning Test UL 94.

INDUSTRIAL APPLICABILITY

The composite magnetic body of the present invention possess fire resistance and is therefore suitable as an electromagnetic interference suppressing body for suppressing high-frequency electromagnetic interference in cellular phones, personal computers, and other types of electronic equipment operated at high frequencies.

CLAIMS

1. A composite magnetic body, comprising a silicone rubber and a soft magnetic powder dispersed in the silicone rubber.
2. A composite magnetic body as recited in claim 1, wherein the silicone rubber is at least one type of material selected from a group of solid silicone rubber and chemically setting liquid silicone rubber.
3. A composite magnetic body as recited in claim 1, wherein the silicone rubber contains an additive comprising at least one element selected from a group of platinum, silicon, titanium, iron, copper, nickel, and cobalt.
4. A composite magnetic body as recited in claim 1, wherein the silicone rubber contains an additive comprising carbon black.
5. A composite magnetic body as recited in claim 1, wherein the soft magnetic powder is a magnetic alloy powder having a flat shape.
6. A composite magnetic body as recited in claim 1, wherein the soft magnetic powder has a specific surface area of 0.1–3 m²/g.
7. A composite magnetic body as recited in claim 1, wherein the soft magnetic powder has an aspect ratio of 3 or more.
8. A composite magnetic body as recited in claim 1, wherein the soft magnetic powder is surface-treated with a coupling agent having a SP value ranging from 6 to 10.
9. A composite magnetic body as recited in claim 8, wherein the coupling agent is at least one compound selected from a group of titanate, aluminate, and silane.
10. A composite magnetic body as recited in claim 1, wherein the soft magnetic powder is surface-treated with a primer having a SP value less than that of the soft magnetic powder but greater than that of the silicone rubber.

11. An electromagnetic interference suppressing body for suppressing electromagnetic interference brought about by the interference of unwanted electromagnetic waves, wherein said electromagnetic interference suppressing body is made of a composite magnetic body comprising a silicone rubber and a soft magnetic powder dispersed in the silicone rubber.

12. An electromagnetic interference suppressing body as recited in claim 11, wherein the silicone rubber is at least one type of material selected from a group of solid silicone rubber and chemically setting liquid silicone rubber.

13. An electromagnetic interference suppressing body as recited in claim 11, wherein the silicone rubber contains an additive comprising at least one element selected from a group of platinum, silicon, titanium, iron, copper, nickel, and cobalt.

14. An electromagnetic interference suppressing body as recited in claim 11, wherein the silicone rubber contains an additive comprising carbon black.

15. An electromagnetic interference suppressing body as recited in claim 11, wherein the soft magnetic powder is a magnetic alloy powder having a flat shape.

16. An electromagnetic interference suppressing body as recited in claim 11, wherein the soft magnetic powder has a specific surface area of 0.1–3 m²/g.

17. An electromagnetic interference suppressing body as recited in claim 11, wherein the soft magnetic powder has an aspect ratio of 3 or more.

18. An electromagnetic interference suppressing body as recited in claim 11, wherein the soft magnetic powder is surface-treated with a coupling agent having a SP value ranging from 6 to 10.

19. An electromagnetic interference suppressing body as recited in claim 18, wherein the coupling agent is at least one compound selected from a

group of titanate, aluminate, and silane.

20. An electromagnetic interference suppressing body as recited in claim 11, wherein the soft magnetic powder is surface-treated with a primer having a SP value less than that of the soft magnetic powder but greater than that of the silicone rubber.

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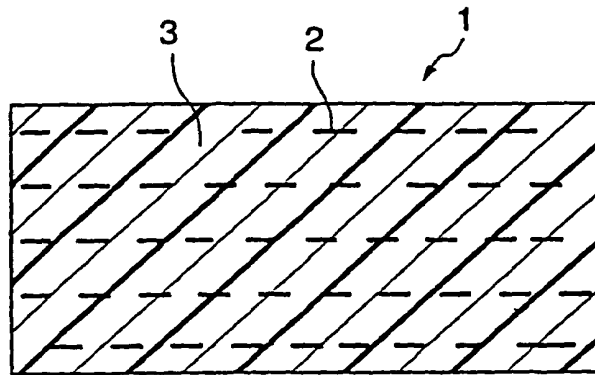


FIG. 1

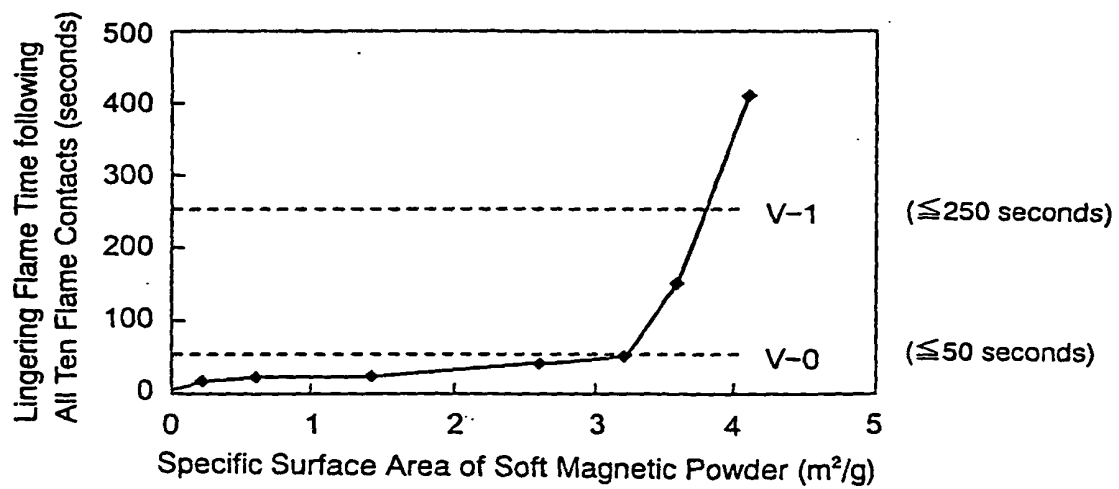


FIG. 2

531 Rec'd PC 13 JUN 2001

INTERNATIONAL SEARCH REPORT

onal Application No

PCT/JP 00/07209

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01F1/26 H05K9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01F H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 21 37 487 A (LICENTIA GMBH) 1 February 1973 (1973-02-01) page 3, paragraph 2; claims 1,3 ---	1-3,6
X	US 4 731 191 A (SWIHART TERENCE J) 15 March 1988 (1988-03-15) column 4, line 65 -column 5, line 2; claims 1,2; example 4 ---	1-3
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 09, 31 July 1998 (1998-07-31) & JP 10 092623 A (TOKIN CORP), 10 April 1998 (1998-04-10) abstract --- -/--	1,8,9, 11,18,19

☒ Further documents are listed in the continuation of box C:

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5 498 644 A (REO NED J) 12 March 1996 (1996-03-12)</p> <p>claims 1,2,4,5</p>	<p>1-3,8,9, 11-13, 18,19</p>

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US 4731191	A	15-03-1988	NONE	
JP 10092623	A	10-04-1998	NONE	
US 5498644	A	12-03-1996	NONE	

